Pump ED 101

The Cost of Pumping – Power Cost & Efficiency

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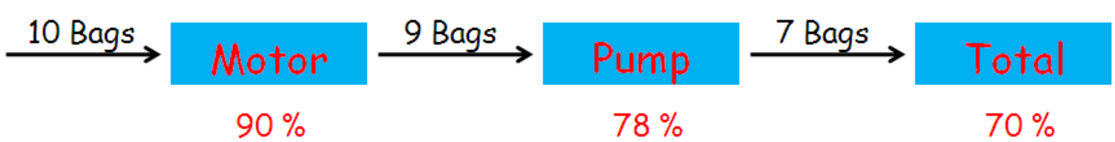
Today's federal requirements dictate the minimum efficiency of an electric motor but they do not have any impact upon the efficiency of a centrifugal pump. A 10HP, 1800RPM motor must meet a minimum efficiency of 90.2% but there are no such restrictions on a 10HP pump. And, that is a good thing. There are times when lower efficiency pumps can actually reduce total operating costs. Vortex sewage pumps are a good example. In most applications, however, high efficiency pumps should be selected as they can drastically reduce electric power costs.

If I did not know better, my brain would tell me that the total efficiency of a pump and motor would be the average of the two individual efficiencies. If a motor is 90% and the pump is 78%, the average would be 84%. That would be ideal but, unfortunately the total efficiency of a motor and pump when operating together is the product of their individual efficiencies and that product reduces the total efficiency to a value that is well below the average. Sometimes this is hard to comprehend because there are so many different units of measure. To make it simple I like to use a very simple energy unit – a bag of energy. Figure 1 illustrates this concept. If 10 bags of energy enter the motor and 7 bags exit the pump, the total efficiency is 70%. If 10 bags enter the motor and 9 exit the motor, motor efficiency is 90%. If 9 bags enter the pump and 7 exit the pump, its efficiency is 78%. The only way we can calculate a total efficiency of 70% is to multiply 90% by 78%.

Total Efficiency = Pump Efficiency X Motor Efficiency



$$0.90 \times 0.78 = 0.70 = 70\%$$

This total or "wire to water" efficiency is important because it is a major factor when calculating the power cost for pumping some amount of water. One of the more common cost units is the cost per thousand gallons pumped and is calculated by the equation below. The power cost per thousand gallons is directly proportional to the cost per kWh and pump head while inversely proportional to pump and motor efficiency. Let's compare the electrical costs for two different pumps.

Cost/1000 gallons = (0.189 X Cost/kWh X Head) / (Pump eff X Mtr eff X 60)

Figures 2 and 3 show the power cost per thousand gallons pumped for two different pumps. Both are real pumps and are very popular in several water markets. BEP for both pumps is 1000GPM @ 127' and the power cost is 10 cents per kWh.

Figure 2 shows the cost per thousand gallons pumped for a pump with a BEP efficiency of 85% driven by a motor with and efficiency of 93%. Wire to water efficiency is 79%. At 60hz the power cost at BEP is 5 cents per thousand. Since the cost per thousand gallons is also directly proportional to head, cost drops to 4.2 cents at 55hz, 3.5 cents at 50hz and 2.8 cents at 45hz. If this pump runs 8 hours a day at 60hz, the annual electrical cost will be $8760.00.

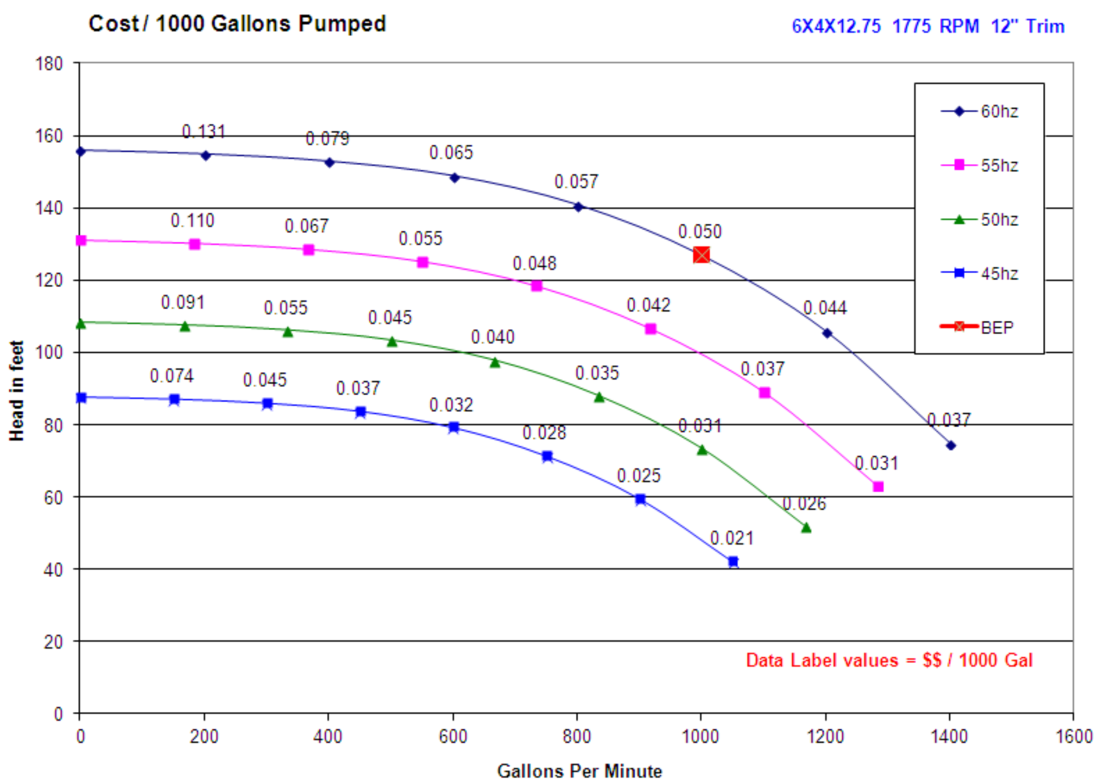
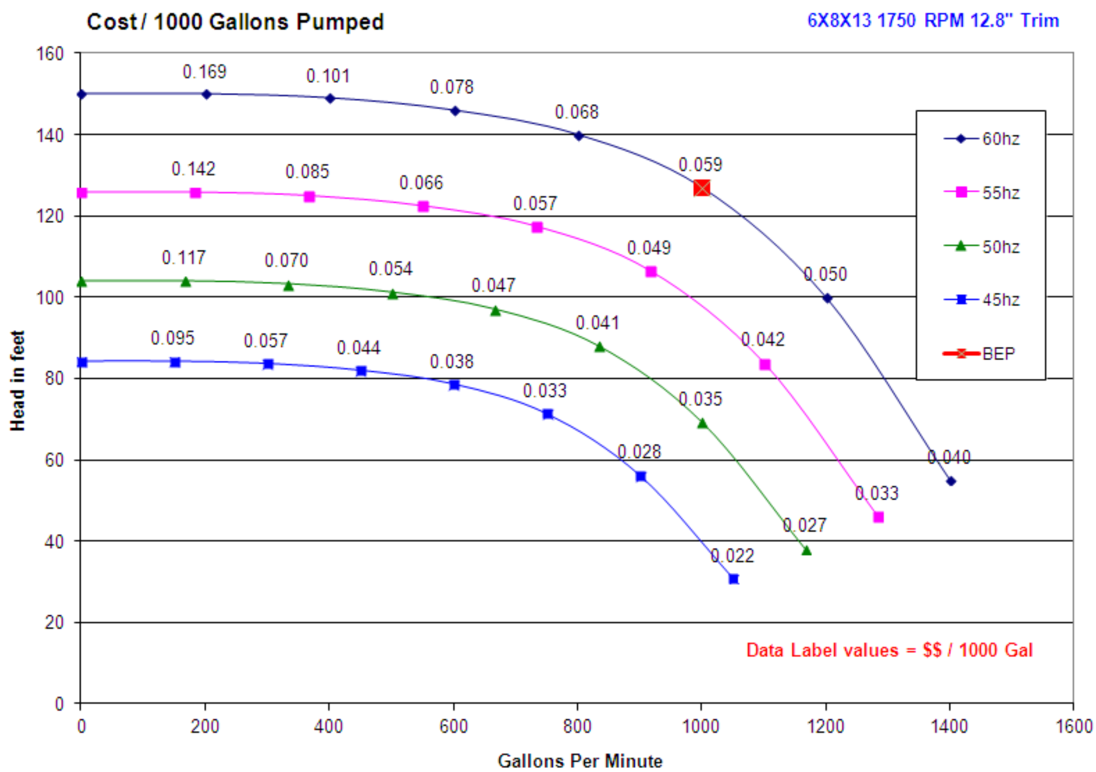


Figure 3 shows the cost per thousand gallons pumped for a pump with a BEP efficiency of 73% driven by a motor with the same efficiency (93%). Wire to water efficiency is 68%. At 60hz the cost at BEP is 5.9 cents per thousand. As with the previous pump, reduced speed also results in a lower cost. Eight hour per day operation at 60hz will result in an annual electrical cost of $10337.00. In this comparison, an 11% reduction in wire to water efficiency results in an 18% increase in power cost.



The US Energy Information Agency reports that the July 2013 average cost per kWh across the US was 10.71 cents. This represents a 3.9% increase from July of 2012. Residential averages were highest at 12.61 cents and industrial were lowest at 7.32 cents. Energy cost also varied greatly by region. The highest average rate was Hawaii and Alaska at 27.2 cents. New England was second at 14.3 cents and the Middle Atlantic states were third at 12.74 cents. The lowest was the West South Central states (TX, LA, AR & OK) at 8.12 cents. The remainder ranged from 8.48 to 11.17 cents. Energy costs will continue to rise so it is in your best interest to make sure that your pumps are operating at maximum efficiency.

Joe Evans is responsible for customer and employee education at PumpTech Inc, a pump & packaged systems manufacturer & distributor with branches throughout the Pacific Northwest. He can be reached via his website www.PumpEd101.com. If there are topics that you would like to see discussed in future columns, drop him an email.